

CLAIMS:

1. An immunogenic composition comprising a polypeptide comprising an amino acid sequence which has at least 85% identity to an amino acid sequence selected from the group consisting of SEQ Group 2 , over the entire length of said sequence from SEQ Group 2, or an immunogenic fragment thereof, and a pharmaceutically acceptable excipient .
2. The immunogenic composition as claimed in claim 1 in which the polypeptide comprises an amino acid sequence which has at least 95% identity to an amino acid sequence selected from the group consisting of SEQ Group 2, over the entire length of said sequence from SEQ Group 2, or an immunogenic fragment thereof.
3. The immunogenic composition as claimed in claim 1 in which the polypeptide comprises an amino acid sequence selected from the group consisting of SEQ Group 2, or an immunogenic fragment thereof.
4. The immunogenic composition of claims 1-3 in which the polypeptide comprises an amino acid sequence which is an immunogenic fragment of the polypeptide of SEQ Group 2 in which said immunogenic fragment is capable of raising an immune response which recognises the corresponding polypeptide of SEQ Group 2 .
5. The immunogenic composition as claimed in any of claims 1 to 4 wherein said polypeptide is part of a larger fusion protein.
6. An immunogenic composition comprising a polynucleotide comprising a nucleotide sequence having at least 85% identity to the nucleotide sequence of SEQ Group 1, over the entire length of said sequence from SEQ Group 1 and a pharmaceutically acceptable excipient.

7. The immunogenic composition of claim 6 wherein the polynucleotide comprises a nucleotide sequence having at least 95% identity to the nucleotide sequence of SEQ Group 1, over the entire length of said sequence from SEQ Group 1.
8. The immunogenic composition of claim 6 or 7 wherein the polynucleotide comprises a nucleotide sequence having the sequence of any polynucleotide selected from the group consisting of SEQ Group 1.
9. An immunogenic composition comprising a polynucleotide encoding a polypeptide comprising an amino acid sequence which has at least 85% identity to an amino acid sequence selected from the group consisting of SEQ Group 2, over the entire length of said sequence from SEQ Group 2, or an immunogenic fragment thereof, and a pharmaceutically acceptable excipient.
10. The immunogenic composition of claim 9 wherein the polynucleotide encodes a polypeptide comprising an amino acid sequence selected from the group consisting of SEQ Group 2, or an immunogenic fragment thereof.
11. An immunogenic composition comprising at least or exactly two, three, four, five, six, seven, eight, nine or ten different *Bordetella*, preferably *B. pertussis*, antigens wherein the antigens are selected from at least two, three, four or five groups of proteins selected from the following:
 - a) at least one *Bordetella* autotransporter protein selected from the group consisting of a polypeptide sharing at least 70% identity with SEQ ID 34, 30, 32, 36, 38, 40, 42, 44, 46, 48, 50, 52, or 54 and BipA and pertactin or an antigenic fragment thereof, preferably the passenger domain thereof;
 - b) at least one *Bordetella* iron acquisition protein selected from the group consisting of a polypeptide sharing at least 70% identity with SEQ ID 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, or 28, or an antigenic fragment thereof;

- c) at least one *Bordetella* lipoprotein selected from the group consisting of a polypeptide sharing at least 70% identity with SEQ ID 56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90, 92, 94, 96, or 98 or an antigenic fragment thereof;
- d) at least one *Bordetella* adhesin selected from the group consisting of FHA, fimbriae 2 and/or 3, pertactin and BrkA or an antigenic fragment thereof; and
- e) at least one *Bordetella* toxin/invasin or antigens involved in toxin/invasin secretion selected from the group consisting of pertussis toxin, adenylate cyclase, dermonecrotic toxin (Dnt), Type III ss or lipopolysaccharide or an antigenic fragment thereof,

wherein the *Bordetella* antigens in the immunogenic composition do not consist of any combination of 2, 3, 4 or all 5 of pertactin, fibriae 2, fimbriae 3, FHA and pertussis toxin.

- 12. The immunogenic composition of claim 11 comprising one or more *Bordetella* iron acquisition protein selected from the group consisting of the polypeptides sharing at least 70% identity with SEQ ID 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26 or 28, or an antigenic fragment thereof.
- 13. The immunogenic composition of claim 12 wherein the *Bordetella* iron acquisition protein is BhuR or an antigenic fragment thereof.
- 14. The immunogenic composition of claim 11-13 comprising a *Bordetella* autotransporter protein selected from the group consisting of a polypeptide sharing at least 70% identity with SEQ ID 34, 30, 32, 36, 38, 40, 42, 44, 46, 48, 50, 52, or 54 and pertactin and BipA or an antigenic fragment, preferably the passenger domain, thereof.
- 15. The immunogenic composition of claim 14 wherein the *Bordetella* autotransporter protein is BipA, or an antigenic fragment, preferably the passenger domain thereof.

16. The immunogenic composition of claim 14 or 15 wherein the Bordetella autotransporter protein is pertactin, or an antigenic fragment, preferably the passenger domain thereof.
17. The immunogenic composition of claim 14-16 wherein the Bordetella autotransporter protein is BrkA, or an antigenic fragment, preferably the passenger domain thereof.
18. The immunogenic composition of claim 14-17 wherein the Bordetella autotransporter protein is TcfA, or an antigenic fragment, preferably the passenger domain thereof.
19. The immunogenic composition of claim 14-18 wherein the Bordetella autotransporter protein is BapA, or an antigenic fragment, preferably the passenger domain thereof.
20. The immunogenic composition of claim 14-19 wherein the Bordetella autotransporter protein is BapB, or an antigenic fragment, preferably the passenger domain thereof.
21. The immunogenic composition of claim 14-20 wherein the Bordetella autotransporter protein is BapC, or an antigenic fragment, preferably the passenger domain thereof.
22. The immunogenic composition of claim 14-21 wherein the Bordetella autotransporter protein is YapE, or an antigenic fragment, preferably the passenger domain thereof.

23. The immunogenic composition of claims 11-22 comprising a Bordetella lipoprotein selected from the group consisting of BipA, the polypeptide sharing at least 70% identity with SEQ ID 56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90, 92, 94, 96 or 98 or an antigenic fragment thereof.
24. The immunogenic composition of claim 23 wherein the Bordetella lipoprotein is MltA or an antigenic fragment thereof.
25. The immunogenic composition of claim 23-24 wherein the Bordetella lipoprotein is MltB or an antigenic fragment thereof.
26. The immunogenic composition of claim 23-25 wherein the Bordetella lipoprotein is VacJ or an antigenic fragment thereof.
27. The immunogenic composition of claim 23-26 wherein the Bordetella lipoprotein is OmlA or an antigenic fragment thereof.
28. The immunogenic composition of claim 23-27 wherein the Bordetella lipoprotein is Pcp or an antigenic fragment thereof.
29. The immunogenic composition of claims 11-28 comprising a Bordetella adhesin selected from the group consisting of BrkA, FHA, fimbriae and pertactin or an antigenic fragment thereof.
30. The immunogenic composition of claim 29 wherein the Bordetella adhesin is FHA or an antigenic fragment thereof.
31. The immunogenic composition of claim 29-30 wherein the Bordetella adhesin is Fimbriae 2 and/or 3 or an antigenic fragment thereof.

32. The immunogenic composition of claims 11-31 comprising a *Bordetella* toxin/invasin or antigens involved in toxin/invasin secretion selected from the group consisting of pertussis toxin, adenylate cyclase, dermonecrotic toxin (Dnt), Type III ss or lipopolysaccharide (LPS) or an antigenic fragment thereof.
33. The immunogenic composition of claim 32 wherein the *Bordetella* toxin/invasin or antigen involved in toxin/invasin secretion is pertussis toxin or an antigenic fragment thereof.
34. The immunogenic composition of claim 32-33 wherein the *Bordetella* toxin/invasin or antigen involved in toxin/invasin secretion is Type III ss or an antigenic fragment thereof.
35. The immunogenic composition of claim 32-34 wherein the *Bordetella* toxin/invasin or antigen involved in toxin/invasin secretion is LPS or an antigenic fragment thereof.
36. The immunogenic composition of claim 11-35 comprising a) FHA, b) pertussis toxin and c) BrkA or a protein sharing at least 70% identity with SEQ ID 34, or an antigenic fragment thereof, preferably further comprising d) pertactin.
37. The immunogenic composition of claim 11-36 comprising a) FHA, b) pertussis toxin and c) BhuR or a protein sharing at least 70% identity with SEQ ID 20, or an antigenic fragment thereof, preferably further comprising d) pertactin.
38. The immunogenic composition of claim 11-37 comprising a) FHA, b) pertussis toxin and c) BapA or a protein sharing at least 70% identity with SEQ ID 40, or an antigenic fragment thereof, preferably further comprising d) pertactin.

39. The immunogenic composition of claim 11-38 comprising a) FHA, b) pertussis toxin and c) BapB or a protein sharing at least 70% identity with SEQ ID 42, or an antigenic fragment thereof, preferably further comprising d) pertactin.
40. The immunogenic composition of claim 11-39 comprising a) FHA, b) pertussis toxin and c) BapC or a protein sharing at least 70% identity with SEQ ID 44, or an antigenic fragment thereof, preferably further comprising d) pertactin.
41. The immunogenic composition of claim 11-40 comprising a) FHA, b) pertussis toxin and c) YapE or a protein sharing at least 70% identity with SEQ ID 52, or an antigenic fragment thereof, preferably further comprising d) pertactin.
42. The immunogenic composition of claim 11-41 comprising a) FHA, b) pertussis toxin and c) VacJ or a protein sharing at least 70% identity with SEQ ID 82, or an antigenic fragment thereof, preferably further comprising d) pertactin.
43. The immunogenic composition of claim 11-42 comprising a) FHA, b) pertussis toxin and c) OmlA or a protein sharing at least 70% identity with SEQ ID 92, or an antigenic fragment thereof, preferably further comprising d) pertactin.
44. The immunogenic composition of claim 11-43 comprising a) FHA, b) pertussis toxin and c) Pcp or a protein sharing at least 70% identity with SEQ ID 96, or an antigenic fragment thereof, preferably further comprising d) pertactin.
45. The immunogenic composition of claim 11-44 comprising a) FHA, b) pertussis toxin and c) MltA or a protein sharing at least 70% identity with SEQ ID 70, or an antigenic fragment thereof, preferably further comprising d) pertactin.

46. The immunogenic composition of claim 11-46 comprising a) FHA, b) pertussis toxin and c) MltB or a protein sharing at least 70% identity with SEQ ID 72, or an antigenic fragment thereof, preferably further comprising d) pertactin.
47. The immunogenic composition of claim 11-46 comprising a) FHA, b) pertussis toxin and c) TcfA or a protein sharing at least 70% identity with SEQ ID 36, or an antigenic fragment thereof, preferably further comprising d) pertactin.
48. The immunogenic composition of claim 11-47 comprising a) FHA, b) pertussis toxin and c) adenylate cyclase, or an antigenic fragment thereof, preferably further comprising d) pertactin.
49. The immunogenic composition of claim 11-48 comprising a) FHA, b) pertussis toxin and c) Type III ss or an antigenic fragment thereof, preferably further comprising d) pertactin.
50. The immunogenic composition of claims 1-49 for the prevention or treatment of *Bordetella pertussis* infection.
51. The immunogenic composition of claims 1-50 for the prevention or treatment of *Bordetella parapertussis* infection.
52. The immunogenic composition of claims 1-51 for the prevention or treatment of *Bordetella bronchiseptica* infection.
53. The immunogenic composition of claims 1-52 comprising a polypeptide that is expressed during the Bvg⁺ early phase of *Bordetella* infection.
54. The immunogenic composition of claims 1-53 comprising a polypeptide that is expressed during the Bvg⁺ late phase of *Bordetella* infection.

55. The immunogenic composition of claims 1-54 comprising a polypeptide that is expressed during the Bvgi phase of Bordetella infection.
56. The immunogenic composition of claims 1-55 comprising an antigen that is expressed during the Bvg- phase of Bordetella infection.
57. The immunogenic composition of claims 1-56, further comprising diphtheria toxoid and tetanus toxoid.
58. The immunogenic composition of claim 1-57 further comprising PRP capsular oligosaccharide or polysaccharide from Haemophilus influenzae b, preferably conjugated to a source of T-cell epitopes.
59. The immunogenic composition of claim 1-58 further comprising hepatitis B surface antigen (HbsAg).
60. The immunogenic composition of claim 1-59 further comprising inactivated polio vaccine (IPV).
61. The immunogenic composition of claim 1-60 further comprising one or more of Men A, C, W or Y capsular polysaccharides or oligosaccharides, preferably conjugated to a source of T-cell epitopes.
62. The immunogenic composition of claims 1-61 further comprising a protein from *N. meningitidis* serogroup B.
63. The immunogenic composition of claim 1-62 further comprising one or more capsular polysaccharides or oligosaccharides from *S. pneumoniae*, preferably conjugated to a source of T-cell epitopes.

64. The immunogenic composition of claim 1-63 further comprising killed attenuated Hepatitis A virus.
65. A vaccine comprising the immunogenic composition of claim 1-64.
66. The vaccine of claim 65 comprising an adjuvant.
67. Use of the immunogenic composition of claims 1-64 in the preparation of a medicament for use in the treatment or prevention of Bordetella disease.
68. The use of claim 67 in the preparation of a medicament for use in the treatment or prevention of both *B. pertussis* and *B. parapertussis* disease.
69. A method for treating or preventing Bordetella infection comprising administering the vaccine of claim 65 or 66 to a host.
70. The method of claim 69 in which both *B. pertussis* and *B. parapertussis* infection is treated or prevented.
71. An immunogenic composition or vaccine substantially as described in the description with references to the drawings.